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Synthesis of Albumen (Egg white) Assisted SnO_2 Nanoparticles by Microwave Irradiation Method

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ABSTRACT

The Tin dioxide nanoparticle is synthesized in the microwave irradiation method with albumen (egg white). This method is simple and cost effect synthesis of SnO_2 nanoparticles. The egg white foam was assisted to increase the reaction rate and this method helps to attain the particle size in the range 75-80nm. The result from X-ray diffraction patterns confirmed the formation of nano crystalline phase with particle size range from 75nm to 80nm. The samples were further analyzed by using Fourier transform infrared spectroscopy (FT-IR), photoluminescence spectrum (Pl), Transmission electron microscope (TEM) and resistivity measurement.

Keywords: Nano powder, Temperature, Resistance, Humidity, Efficiency.

INTRODUCTION

Tin dioxide is a stable and largely and n-type semiconductor material with band gap of (Eg~3.7eV) and it has been widely used in various applications such as gas sensor[1-3], photo sensor[4], antistatic coating[5] etc. The nanosized tin dioxide has a great potential in wide applications, due to its higher surface to volume ratio. Tin dioxide nanomaterials have been prepared by many techniques namely: chemical precipitation[6], microwave technique[7], combustion route[8], sol-gel[9], solvothermal[10], hydrothermal[11], sonochemical[12]. The researchers state that the utility of egg white simplifies the process and paves the way for another alternative, simple and economical

synthesis process for production of nanoparticle. This is because egg white has the properties like gelling, foaming and emulsifying with high nutrition qualities and also their solubility in water and its ability to amalgamate with metal ions.

In the present investigation we have adopted cost-effective and simple microwave technique due to its unique properties. Microwave generates high power densities, enabling efficient production at decreased production cost. Microwave systems are more compact and thus require smaller equipment space. Microwave energy is precisely controllable and can be turned on and off instantly, eliminating the need for warm-up and cool down. This increases production runtimes, reduces both cleaning times and chemical costs. Microwaves are a non-contact drying technology; microwave energy is selectively absorbed by areas of greater moisture. This results in more uniform temperature and moisture profiles, improves yields and enhanced product performance.

In this work, we have prepared tin dioxide nanoparticles in short time (10 min). This method has strongly supported to achieve the yield rate of tin dioxide nanoparticle.

EXPERIMENTAL PROCEDURE

A 0.1M solution of tin (II) chloride in deionized was prepared. The 5ml of freshly extracted egg white was mixed with 25ml of deionized water and stirred. The obtained egg solution was added by drop in 0.1M tin hydroxyl solution. Then p^H of the solution was maintained at 8 by adding liquid ammonia drop wise. The resulting precipitate was washed with water more than ten times until no chlorine ions are detected. The precipitate was further washed with ethanol to remove NH_4^+ ions. The resulting precipitate was irradiated with household microwave oven for 10min. The radiation frequency was 2.45GHZ and its power up to 1KW.

X-ray powder diffraction (XRD) patterns of all the samples were measured on a bruker Axs D8 advanced diffractometer with monochoromatic cukα radiation (λ=1.5406 A°). The Fourier transform infrared spectra (FT-IR) of the samples were collected using a 5DXFTIR spectrometer. The morphology of the powder was observed by Transmission Electron microscopy (TEM). The photoluminescence spectra of the samples were collected from cary Eclipse (el02045776) fluorescence spectrometer in the wavelength range of 400 to 800 nm.

RESULTS AND DISCUSSION

1.1 XRD PATTERN

The XRD pattern of sample-A and sample-b showed the formation of SnO_2 crystals with cassiterite type tetragonal phase structure. Sample-B process had changed the tin dioxide towards higher order of crystallinity. The average crystallite size of the tin dioxide crystal was calculated from Debye-scherrer formula and found to be 75nm to 80nm.The broadening of FWHM in the XRD spectrum indicates formation of smaller particles after the microwave irradiation with using egg white solution.

The lattice parameter of the crystal were calculated as a=4.7471A° and c=3.1806A° which matches well with the

standard values of (a=4.74A°,C=3.19A°) tindioxide. The following miller indices [110][101][011][200][211][220][310][301][202] were observed JCPDS #41-1445.

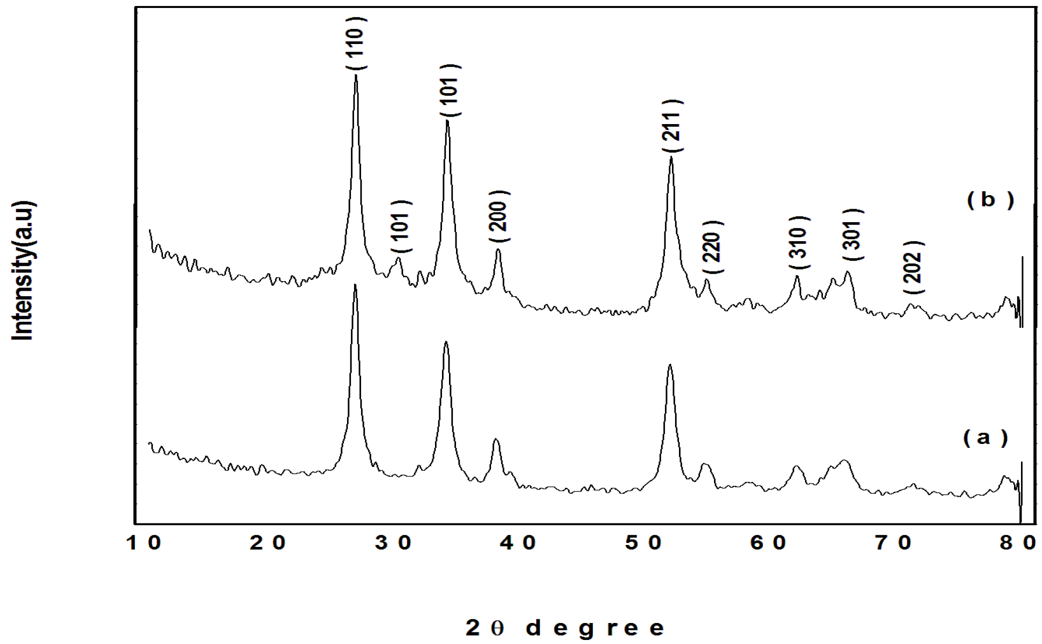


Fig 1.1 XRD pattern of tin dioxide nanoparticles a) before using albumen with microwave for 10min b) after using albumen with microwave for 10min

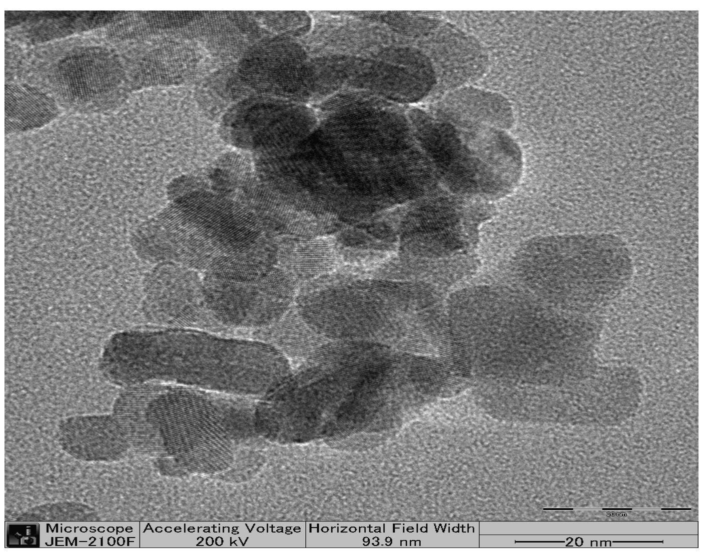


Fig 1.2 TEM Micrograph of tindioxide exposed to albumen with microwave for 10 min.

1.2 TEM MICROGRAPH

The morphology and particle size of the tin dioxide nanoparticles were observed using TEM micrograph. The presence of mono dispersed spherical shaped particles with size ranging from 76nm was observed. The calculated particles size from XRD investigation matches well with the particles size observed from TEM micrograph. These results suggest the formation of monocrystalline tindioxide nanoparticles.

1.3 EDS SPECTRUM

The EDS of tin dioxide nanostructure confirmed that the sample was composed of tin and oxygen without any impurities. The peak corresponding to 2.367eV was due to grid use for EDS analysis.

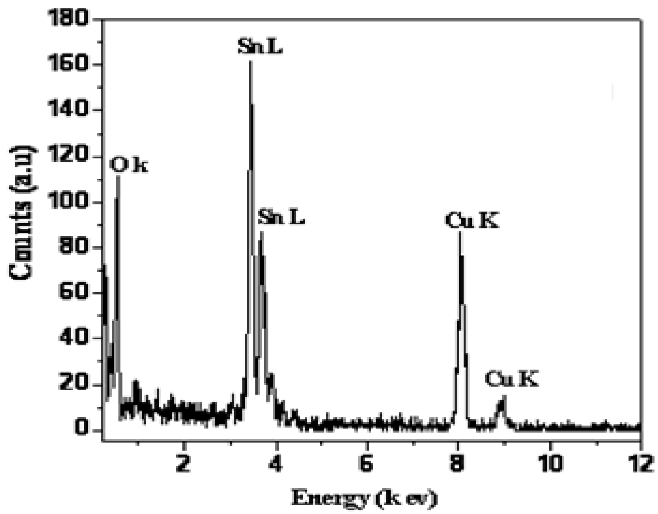


Fig 1.3. EDS Micrograph of tin dioxide exposed to albumen with microwave for 10 min

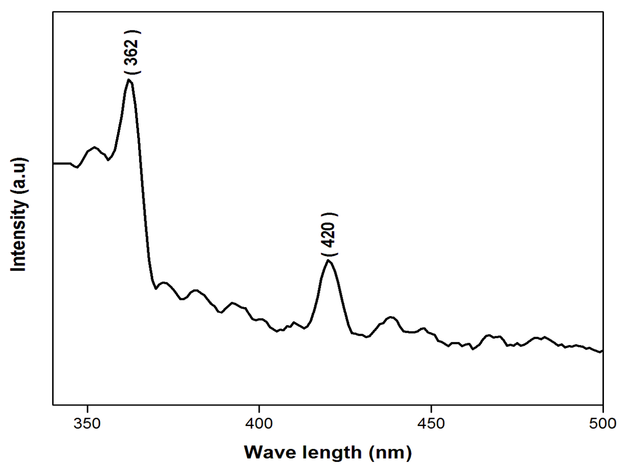


Fig1.4 photoluminescence spectrum of tindioxide exposed to albumen with microwave for 10 min

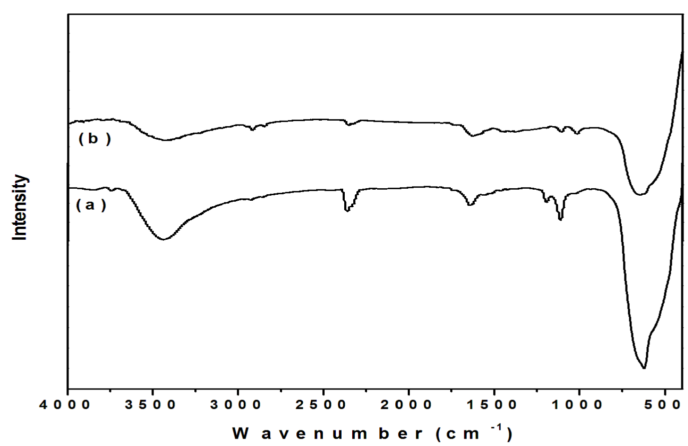
1.4 PHOTOLUMINESCENCE SPECTRUM

The Oxygen deficiency and lattice distortion of the tindioxide samples were analyzed using photoluminescence spectrum and it is shown in Fig 1.4. The emission property of the samples were analyzed from photoluminescence investigation and the energy of emitted light relates to the difference in energy levels between two electron states such as exited and equilibrium state which are involved in the transition.

The sharp near band-edge emission at 362 nm and it was attributed to a well known recombination of free excitations. A blue band observed at 420nm was attributed to the transition between vacancy of oxygen and interstitial oxygen.

1.5. FT-IR SPECTRUM

The FT-IR spectrum further supports the presence of tin dioxide functional group for before and after adding egg white solution samples respectively. Samples (a) the absorption band 622.86 cm^{-1} in Fig 1.5(a) was ascribed to the presence of tin hydroxyl group (Vos no). After egg white sample had absorption band at 652.34 cm^{-1} Fig 1.5(b) Which is attributed to oxide bridge functional group (Vos no). The peak at 1633 cm^{-1} was ascribed to the vibration of NO_3^- ions. The absorption band at 3433 cm^{-1} attributed to V_{OH} stretching vibration of surface hydroxyl group absorption water which has been observed due to the adsorption of water molecules from ambient atmosphere.



1.5. FT-IR Spectrum of tin dioxide nanoparticles a)before using albumen with microwave for 10min b) after using albumen with microwave for 10min

1.6 .Resistance measurement

Fig. 1.6 shows the temperature dependent resistance measurement of SnO_2 nanoparticles using albumen (egg white) with microwave for 10min. The decrease in resistance with increase in temperature (above 50°C) could be attributed to negative temperature coefficient and semiconducting nature of the SnO_2 nanoparticles. The

resistance decreases with increasing temperature for the prepared SnO_2 sample using egg white (albumen) with microwave for 10 min resembles the characteristic behavior of a typical semiconducting material. I.e. the adsorption rate of oxygen on the surface is higher than it's desorption rate and further increase in temperature results in the semiconducting nature. The resistance of SnO_2 nanoparticles at ambient temperature was found to be $23x10^3$ Ω and temperature at 250°C was found to be $1.8\times10^2\Omega$, which implies the enhancement in electrical conductivity of SnO_2 nano-particles. The result confirms that the prepared as synthesized SnO_2 nanoparticles were having good electrical response with temperature. These types of materials are preferable of gas sensing and solar cell applications.

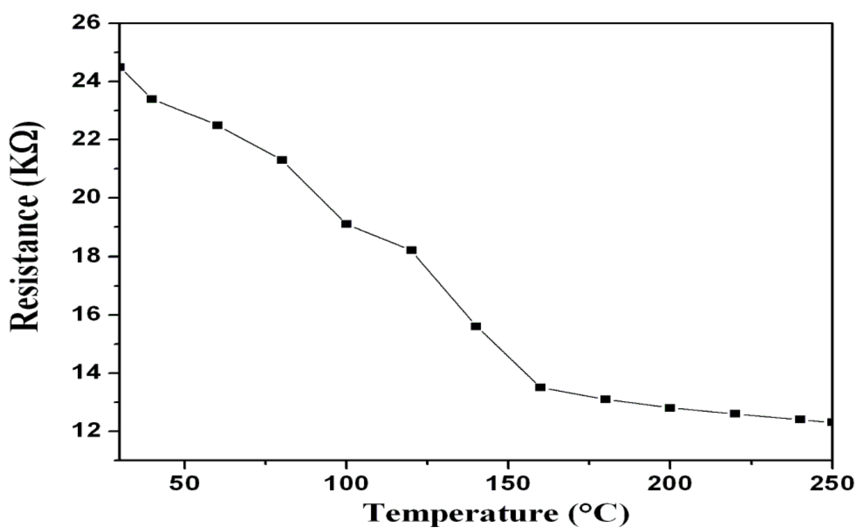


Fig. 1.6. The variation of resistance with temperature of SnO_2 nanoparticles using egg white (albumen) with microwave for 10 min

CONCLUSION

In summary, tin dioxide nanoparticles were synthesized by egg white assisted microwave irradiation with in 10 min. The presence of single crystal tin dioxide nanoparticles assembled in spherical structure is confirmed by TEM micrograph. The resistance of the sample decreased with time shows the semiconducting nature. The microwave irradiation with albumen consumes lesser time for synthesizing nanopowder with a controlled particle size. The generation of tin dioxide nanoparticles with egg white (albumen) at a large scale and low cost for practical applications and nanoparticle size with different structure is possible. The temperature dependent resistance measurement study confirms that the prepared SnO_2 nanoparticles were having

good electrical response with temperature. These types of materials are preferable of gas sensing and solar cell applications.

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